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INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

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COUNTRY	USSR (Azerbaydzhan SSR)	REPORT	[redacted]
SUBJECT	Research Projects at the Azerbaydzhan Industrial Institute (AzII)	DATE DISTR.	6 May 1958
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SOURCE EVALUATIONS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

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1. [redacted] a 33-page [redacted] document, [redacted] containing information on projects under development from 1945 until March 1957 at the Azerbaydzhan Industrial Institute (AzII). [redacted]

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2. At the AzII, the Chair of General and Theoretical Fundamentals of Electrical Engineering (kafedra obshchey i teoreticheskikh osnov elektrotekhniki) was concerned with the development of electrical measuring instruments to be used in the petroleum industry. From 1945 until March 1957, the following projects were developed by the Chair of General and Theoretical Fundamentals of Electrical Engineering in cooperation with the Chair of Automatics and Telemechanics (kafedra avtomatiki i telemekhaniki), which was organized in 1955 - 1956:

   a. An electric indicator for measuring the weight of the drill pipe column suspended from the swivel of a block and tackle system.

   b. A meter for measuring the consumption of mud solution. This instrument allowed the drilling crew to determine the optimum rate for the upward flow of the mud solution and to detect disturbances in the circulation of the mud solution.

   c. An indicator for determining the rate and character of the feed of the drilling tool during a drilling operation.

   d. An electric manometer for controlling the pressure of the mud solution pump.

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STATE	x	ARMY	x	NAVY	x	AIR	x	FBI		AEC		OSI Ev	x	ORR Ev	x

(Note: Washington distribution indicated by "X"; Field distribution by "#".)

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e. An electric tachometer for measuring the revolutions per unit of time of the rotary table, drill pipe column, and bit.

f. A wattmeter for controlling the power of electric motors used in the drilling unit.

g. An AC potentiometer.

h. An inclinometer for measuring dip, azimuth, and speed during inclined drilling.

i. A device for measuring rock porosity electrically. It was planned to operate the instrument at a high frequency.

j. A gauge for measuring electrically the thickness of the chromium coating of the tubes of pumps used in the oil industry.

k. A device for measuring ground pressure at tunnel arches, ordered by the Mingechaurstroy in 1953 - 1954.[1]

l. An instrument for the diagnosis of human diseases through the measurement of human skin resistance to electric current. This device was ordered by the Azerbaydzhan Medical Institute (AMI).

The document describes the basic operating principles of each of the above devices except those of the inclinometer and the device for measuring rock porosity. Also discussed is the research being conducted in 1957 by the Chair of General and Theoretical Fundamentals of Electrical Engineering on a project known as the "communication channel".[2] Work on this project was also carried on at the Lvov Polytechnic Institute.

3. The AzII also developed equipment ordered by military customers. [redacted] 25X1 officials of AzII had worked on the design of a machine gun. The machine gun was tested near Moscow and was built at the Plant i/n Leytenant Shmidt in Baku.

4. Throughout the document are the names of engineers and technicians who worked on projects at AzII, as well as the titles of books and periodicals which contain information on AzII projects.

1. [redacted] Comment: Mingechaur, Azerbaydzhan SSR, is located at N 40-45, E 47-03. 25X1

2. [redacted] Comment: During drilling operations with an electric drill, the electric power fed to the asynchronous motor is transmitted by means of a special cable running inside the drill pipes. The running of the cable inside the drilling pipes complicates the drilling process and makes it more expensive. In many cases, the electric power supply is cut off as a result of damage at the cable connection point. The drill pipes produced in the USSR do not have a communication channel running along their walls [sic] [redacted] and Soviet engineers must therefore find a method for solving this problem. 25X1 25X1

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(electrical measuring instruments such as tachometers, wattmeters, potentiometers, inclinometer, manometers and other devices for petroleum drilling and measurement of human skin resistance to electricity)

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With regard to problems of a military nature [redacted]

[redacted] 25X1

1. [redacted] 25X1

[redacted] the director of the Institute during the war (1941-44), Sadyg Balayevich Godzhaev, and the docent of the Chair for Machine Parts, Rza Talybovich Talybzade, worked on the design of a machine gun. (Rza Talybovich Talybzade) is the present head of NIS at AzII). The machine gun was tested near Moscow, and the Plant imeni Leytenanta Shmidta built this machine gun. The Plant imeni Leytenanta Shmidta is located in the Eight Zavakzal'nyy Rayon of Baku.

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2. In 1951-52, the chair for General and Basic Teheoretical Electrical Engineering at AzII built a thickness gauge for measuring the thickness of paint coatings on oil pipes used in marine drilling. In view of the lack of a source of alternating current near the location of the thickness measurement point, the instrument was designed to use direct current supplied by a battery. This instrument was described at that time in the journal "Zavodskaya Laboratoriya" (Plant Laboratory) in an article by the following authors: G. A. Alizade; A. M. Melik-Shakhnazarov; T. M. Aliyev, with the collaboration of Osipov. The "Parkommuna" plant had ordered this instrument. This plant was engaged in ship repair or ship construction work, and was located on the shore of the Caspian Sea in Baylovo, a suburb of Baku. The plant representative, upon receiving the instrument, [redacted] requested an estimate on 2 types of projects submitted by the plant requiring external thickness measurement of steel sheets. [redacted]

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The problem of measuring the thickness of metal sheets was raised by the "Parkommuna" plant, which had ordered the paint thickness ~~caliper~~ gauge. [redacted] the plant did not intend to use the thickness caliper for measuring the thickness of paint coatings on pipes, but that this ship repair plant used the instrument to determine the thickness of paint coatings on ships. 25X1

3. In 1952-53, [redacted] the construction of a thickness ~~caliper~~ gauge for measuring the thickness of chrom~~e~~ium coatings, equipped with a transducer having an Ш shape, [redacted] This instrument was ordered by a plant in the Udmurt/ ASSR. [redacted] this plant was earlier located in Baku, and at present is located in the Udmurt/skaya ASSR. 25X1

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During the war (1941-44), the plant was evacuated. Two instruments of the same type were built in accordance with the plant order. With these instruments it was possible to measure the thickness of non-magnetic coatings, both on pipes with a diameter of 45 to 90 mm, and on steel sheets. The limit of measurement ranged from 0 to 150 μ.

<u>Conclusions</u>. The AzII built instruments and received funds from customers regardless of whether the orders were of a military nature or not.

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In 1957, the AzII was engaged in work on the "communication channel" [redacted]. According to Professor Z. B. Y~~E~~l'yashevich, Head of the Chair for General and Basic Theoretical Electrical Engineering, this was a topic financed by the state budget and work in this field was conducted both at the AzII and at the L'vov Polytechnic Institute. If work on the topic "communication channel", a topic connected with the petroleum industry, was planned in ~~2~~ two locations of the USSR, it is apparent that military problems can also be handled in the same manner. 25X1

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[redacted]

II. Projects Under Development at the Azerbaydzhan Industrial Institute (AzII) 25X1

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(1) At the AzII the Chair of General and Basic Theoretical Electrical Engineering was engaged in matters relating to measurement with electrical measuring instruments in the petroleum industry. The chief of this chair was Professor Z. B. Yel'yashevich. During the period from 1945 to 1950, docent L. F. Kulikovskiy was actually in charge of all scientific research work. Kulikovskiy, together with A. M. Melik-Shakhnazarov, developed electric meters for controlling drilling processes. After Kulikovskiy had defended his doctor's dissertation he was transferred to Kuybyshev. At the present time, Melik-Shakhnazarov is in charge of this work.

In 1957, the Chair of General and Basic Theoretical Electrical Engineering was working on a project known as "communication channel." Work on this project was also carried out at the L'vov Polytechnic Institute.

The problem of the "communication channel" can be defined as follows: during drilling operations with an electric drill, the electric power fed to the asynchronous motor is transmitted by means of a special cable running inside the drill pipes. The running of the cable inside the drilling pipes complicates the drilling process and makes it more expensive. In many cases, electric power supply is cut off as a result of damage (or breakdown) at the cable connection point. [redacted] 25X1

The drill pipes produced in the Soviet Union do not have a communiction channel running along their walls [redacted], and Soviet 25X1

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engineers must therefore find a method for solving this problem.

~~Assistant Professor~~ Docent Melik-Shakhnazarov has apparently solved this problem in the following manner: at the end of each pipe section an induction transducer is mounted, as shown in the sketch below:

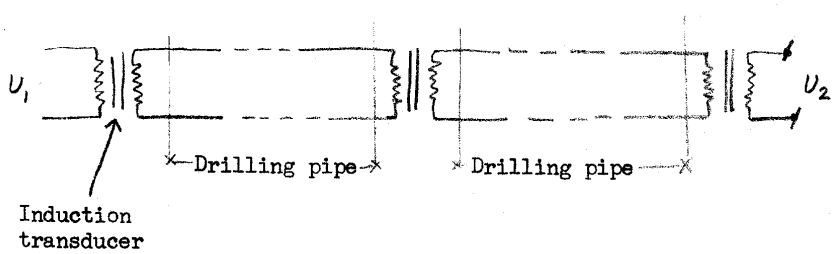

Fig. 1

Melik-Shakhnazarov was awarded an author's certificate for this invention and the solution of the problem in 1956.

[redacted]

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The units were built by Yuriy Aleksandrovich Meshcheryakov, an expert instrument ~~construction worker~~ builder, and were made of solid ferro-magnetic material (steel) of cylinder shape, 4 cm in diameter and 4 cm high. These induction transducers are mounted at the center of the drilling pipes near the coupling.

The following people, in addition to A. M. Melik-Shakhnazarov, are working on design projects in this field: Yuriy Vasil'yevich Grachev; Tofig Mamedovich Aliyev; Gashchim Alimamedovich Alizade.

Projects Developed at the Azerbaydzhan Industrial Institute From 1945 to March 1957

1. Electric weight indicator

This indicator directly measures the weight of the drill pipes column suspended on a swivel of the block and tackle system. The axial

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pressure is determined as the difference between the weight on the swivel when the instrument hangs freely and the load when the instrument transfers part of its weight through the bit to the well stope.

There are 3 types of weight indicators: hydraulic, electrical and mechanical.

The principal shortcomings of the hydraulic weight indicator are the following:

a) Recordings are dependent upon the diameter of the cable

b) Recordings vary with the temperature of the surrounding atmosphere

c) Recordings are dependent upon fluid leaks and the presence of air.

The electrical weight indicator has the following main advantages:

a) Recordings are not dependent upon the diameter of the cable

b) The possibility of effecting remote transmission

c) Ease in modifying the sensitivity of the instrument

d) The possibility of recording indexes of axial pressure alone at any depth range

e) High accuracy

The electrical weight indicator in the same fashion as the hydraulic indicator, is connected to the fixed end of the block and tackle cable, measuring its tension by the change of the angle of bent in the cable under the action of the load.

The electric weight indicator consists of two basic elements. The first one is the so-called elastic element, the purpose of which is to take up the tension of the fixed end of the block and tackle cable and to convert this tension into a proportional emf (electromotive force).

The second element of the electric weight indicator is a ferrodynamic meter of the recording or indicator type.

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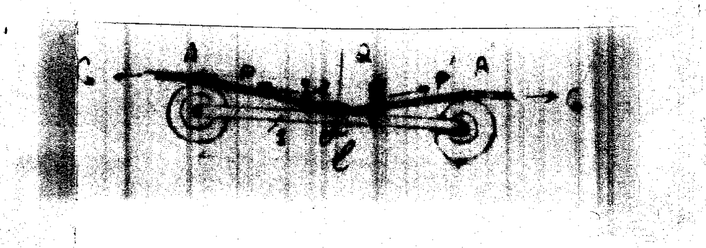

Fig. 2

The elastic element of the electrical weight indicator is mounted on the fixed end of the block and tackle cable by pressing this cable to the seat with a strap. The cable in its lower section touches the rollers and the seat, bending at the same time at a certain angle.

Under the action of the weight of the drilling instrument applied to the hook of the block and tackle system, the fixed end of the block and tackle cable undergoes a tensile stress G-G'. This stress, as a result of the bending of the cable will cause a stress $Q = 2G' \sin \alpha$ at point O. (see figure 2 above) Into the expression for stress Q enters stress G' which differs from the cable tensile stress G by a magnitude of force of friction of the cable proper against the support as well as between cable strands during its bending.

Under the action of this stress, a sag of steel plates 1 takes place.

The sag of plate 1 will result in a change in the position of central point O in relation to points located at a certain distance from point O. Thus, stress Q causes a proportional displacement of the mobile element in the induction transducer in relation to its fixed element. As a result of such a displacement, the emf E_{Δ} of the secondary circuit of the transducer will change its value.

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Since the emf E_Δ of the secondary winding of the transducer is applied to the frame of the ferrodynamic meter, a current will start flowing through the frameof the instrument under the action of this emf. This current, in reacting with the magnetic flux in the gap of the magnetic circuit, will give rise to a torgue. Under the action of this torguw, the loop of the instrument will keep moving until emf is equal to emf E_Δ in the secondary winding of the induction transducer.

The change of emf E_Δ is directly proportional to the sag of the steel plates, and this sag in turn is related to the cable tension created by the load on the hook of the block and tackle system.

2. Mud Solution Meter

Operating principle of the meter - The rock particles obtained during operation of the bit in the well stope are brought to the surface in a continuous flow of mud solution, pumped into the well through the drill pipes.

Maximum drilling is achieved only when at a given axial pressure the well stope is well cleaned.

The rate of flow of the mud solution in the space between the column of the drilling pipes and the face of the well is established in accordance with the nature of the rock that is drilled and with the magnitude of the axial pressure.

At present, the maximum consumption of the mud solution amounts to 50 liters per second at a well depth of 1500 meters. The presence in the drilled well of an instrument showing the consumption of mud solution allows the drilling crew to determine the optimum upward flow rate of mud solution, and also permits to determine the moment any sisturbance in the circulation arises as a result of the escape of the solution into cracks of the rock formation.

The mud solution meter consists of 3 basic elements:

a) A measuring trough

b) A float connected with an induction transducer for measuring angular displacement

c) Ferrodynamic measuring units of the recording and indicator type

The consumption of mud solution is determined at the heigh of the level in front of the spillway or tapering according to the formula

$$Q = mFH^{1/2}$$

where m is the consumption coefficient

F is the cross-section of the spillway in cm^2

H is the height of the fluid level in cm

The height of the liquid level in the meter is measured by a float, attached to one end of an arm, the other end of which is connected through a brushing with the axle of the induction transducer for angular displacements. The frame of this unit is connected with the frame of the ferrodynamic recording instrument and with the frame of the indicator instrument. Thus, a change in the position of the float measuring the level of the mud solution results in a change of the emf of the frame of the induction transducer, and since the frame of the transducer is connected with the frames of the ferrodynamic measuring instruments, any change in the level will cause a displacement of the indicators in these instruments.

In this manner, the scale of the recording instruments can be graduated in units of consumption (liters per second).

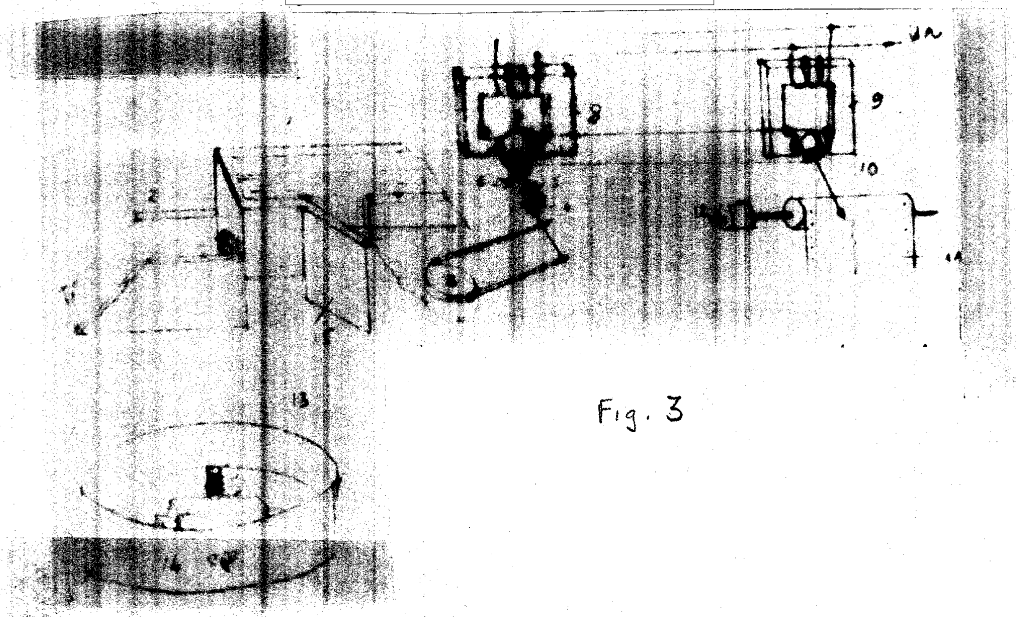

Fig. 3

1. Trough for circulatory system
2. Spillway
3. Float
4. Gear section
5. Gear wheel
6. Counter spring
7. Frame
8. Induction transducer
9. Ferrodynamic recorder
10. Recorder frame
11. Diagram paper
12. Clock mechanism
13. Float electromagnet
14. Flat steel plate
15. Pocket

The primary element of the mud solution meter consists of a float (3), an arm and an induction transducer for angular displacements (8). The float is a cylinder of aluminum sheet 1 mm thick, with a diameter d of 140 mm and a height h of 40 mm. The float has a protective covering which protects it from corrosion.

[redacted]

On the axle of the transducer a gear section (4) is mounted which engages a gear wheel (5) mounted on the same axle as the frame of the transducer. The transmission number of the gear system is equal to $i = 3$.

To close the gap between the gear section and the gear wheel, which affects the reading of the instrument, a helical spring (6) is mounted on the axle of the frame, which presses the teeth of the gear section and of the gear wheel together.

A change in the position of the float results in the rotation of the frame of the transducer, which in turn causes a change in emf and gives rise to a current in the frame of the recording instrument.

The float undergoes a maximum displacement along a vertical line of 200 mm.

Installation of the float directly in the trough in front of the spillway or in front of the Venturi tube opening causes the appearance of a vortex flow of the mud solution in the vininity of the float as a result of the relatively high liquid flow rate. This vortex flow causes a distortion in the instrument recordings. To overcome this distortion, a special pocket (15) is installed on the side of the measuring section of the trough.

The recordings of the instrument can be affected by forces of the structural viscosity of the mud solution. To overcome this influence, an electromagnet (13) is installed inside the float, the field coil of which is fed by a voltage having an industrial frequency of 50 cps. The core of the electromagnet is made of a steel plate attached to the bottom of the float.

A spillway (2) with a ground opening having round edges is installed above the drop in the trough system to ensure circulation of the mud solution.

[redacted]

3. Feed Indicator for Drilling Tool

With the help of this tool, it is possible to determine the magnitude and character of the feed of a drilling tool during well drilling.

Recordings of the feed indicator allow a determination of the hardness of the rock formations being drilled, the location of the top and bottom sections of layers and intercalations, their height, the mechanical speed of passage, the wear moment of the bit and the magnitude of irregular feed of the tool. The same diagram of recordings can help establish the quality of drilling work, by determining both the time necessary for passage through 1 meter of rock and the number of operations nonnected with the washing and the operation of the drilled well stope.

The feed indicator of the drilling tool operates in the following manner:

As the bit works its way through the rock, the driller feeds the drilling tool to the bottom of the well. During this operation, the driller, by releasing the brake on the winch drum, allows the drum to release a section of the compound pulley cable under the action of the weight of the drilling tool. This will cause the hook of the block on which the drilling tool is attached to sink down, together with the drilling tool, to a certain depth. Under the action of the vertical displacement of the hook, an angular shift of the rollers supporting the compound pulley cable takes place.

Since a measuring roller is affixed to one of the rollers of the crown block, a turn of the crown block roller will result in a corresponding turn of the measuring roller. Thus, the feed of the drilling tool into the oil well will result in a rotation of the measuring roller, whereby the rotation angle of the measuring roller is proportional to the travel distance of the drilling tool.

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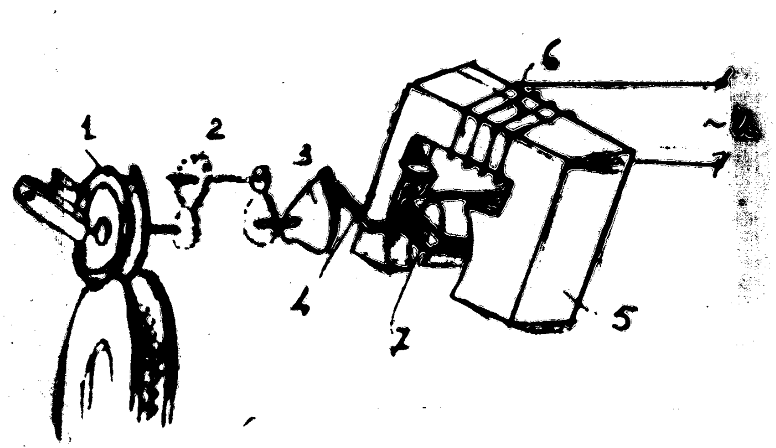

Sketch of the primary element of the feed indicator

1. Measuring roller
2. Gear and pinion mechanism with a transmission ~~efficient~~ ratio of 4 to 1
3. Profile plate
4. Arm
5. Induction transducer for angular displacements
6. Field coil
7. Frame

The measuring roller (1) causes the rotation of the profiled disc (3) by means of the gear and pinion mechanism. When the circumference of the measuring roller is equal to 1 meter, and when this roller is mounted on the second roller of the crownblock, travel of the drilling tool along a distance of 1 meter will cause the measuring roller to rotate twice.

Rotation of the profiled plate (3) will impart to the arm (4), which presses against the surface of this plate, a reciprocal (back and forth) motion.

Since arm (4) is connected with frame (7) of the induction transdueer for angular displacements (5), this frame will also perform cyclic angular movements between two extreme positions. During this displacement of the frame of the induction transducer, the emf of this frame also undergo a cyclic change from E_{max} to E_{-max} as a result of a change in the magnetic interlinkage.

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The frame (7) of the induction transducer is connected with the frame of a ferrodynamic measuring instrument of the recording type. during two rotations of the measuring roller (corresponding to the travel of the drilling tool over a distance of 1 meter), the needle of the self-recording instrument will move from a left position to the extreme right. This movement will be recorded in the form of a saw-toothed curve forming a series of triangles with sides of different length. The length of the bases of these triangles, per unit time, corresponds to 2 meters of feed of the drilling tool at the given 4 to 1 transmission ratio.

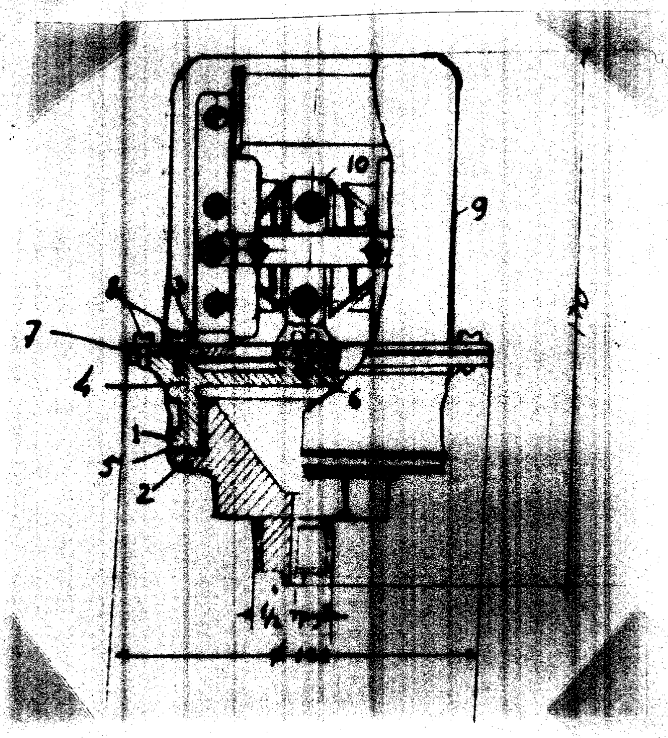
As shown in actual operations, this arrangement of the primary element of the feed indicator results in considerable errors due to vertical vibrations of the drilling tool. These errors are cused by the fact that in view of the considerable weight of the primary element, under the action of vibration, inertia forces applied to the measuring roller result in tearing it off from the rim of the crown block roller. The absence of contact, during a certain period of time, between the measuring roller and the crown block roller, causes shipping of the measuring roller which constitutes the source of the error. For this reason, it has been the practice lately to avoid the use of a measuring roller in order to avoid the action of vibration, and connection between the crownblock roller and the induction transducer is achieved by means of a belt or chain transmission in which the hub of the crown block roller acts as the leading pulley.

4. Electric Manometer for Controlling the Pressure of the Mud Solution Pump

In the practice of drilling operations, the mud solution is pumped into the well by means of two-cylinder piston pumps of the horizontal type.

The manometers used at present for pressure control of the pump are equipped with a Bourdon spring and wear out rapidly in view of the pulsating nature of the pressure. Their useful life runs to 5-6 months. If, in addition, mud solution enters into the interior of the spring, the life of these manometers is further reduced.

The new manometer developed at AzII is an electric manometer of the chamber types, and is free of the shortcomings listed above.



The manometer consists of a primary element (pressure chamber) and of an induction transducer.

The primary element of the manometer consists of the body (1) of the pressure chamber, a nipple (2), a mounting washer (3), a membrane (4), a copper sealing gasket (5), a pin (6), a rubber gasket (7), clamping screws (8), a jacket (9) and an induction transducer (10).

The pressure chamber is made of heat-treated steel 60C2. The membrane (4) is subjected to heat treatment to remove the decarburized layer and is polished. This treatment permits to reduce the influence of residual deformation. The principle of operation of the electric manometer is the following: during feeding of the working agent, the pressure of which is to be measured, a bending of the membrane (4) takes place. This bending can be expressed with sufficient ~~precision~~ accuracy in terms of pressure and basic dimensions of the membrane by the following equation:

$$f = 0.17 \frac{G R^4}{E \delta^3}$$

where f is the bending, in cm

G is the chamber pressure in kg/sq cm

E is the modulus of elasticity in kg/sq cm

R is the radius of the membrane in cm

δ is the thickness of the membrane in cm

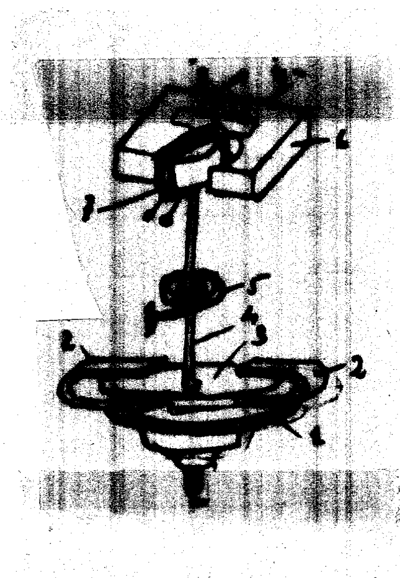
The maximum ~~tension~~ stress, arising in the membrane, can be found from the equation $\sigma = 0.75 \frac{GR^2}{\delta^2}$. Under the action of the bending of the membrane, a displacement of the mobile core in the transducer (10) occurs. This displacement results in a proportional change of emf E_Δ induced in the secondary winding of the transducer. In this manner, the emf E_Δ of the secondary circuit of the transducer is a function of the pressure in the manometer chamber, i.e. $E_\Delta = f(G)$, as a result of which the scale of the ferrodynamic measuring instruments, connected with the induction transducer of the manometer, is graded in units of pressure, i.e. in kg/sq cm.

The electric manometers developed at the Azerbaydzhan Industrial Institute are equipped with a chamber designed for a maximum pressure of 150 kg/sq cm. These manometers have maximum measuring ranges of 50, 75, 100 and 150 kg/sq cm. These ranges are attained by changing the total air gap and also by using a sectionalized secondary winding in the induction transducer.

5. Electric Tachometer for Measuring the Number of Rotations of the Rotary Table

The electric tachometer is intended to measure and record the angular velocity of the drilling instrument. The presence of an instrument capable of measuring the number of rotations (rpm) per unit of time of a drill pipe column and of the bit, make it possible during the study of the drilling process, to determine the effect of this parameter upon the mechanical speed of shaft sinking, upon the wear rate of the bit, and upon the power expended for rotating the drill pipe column under idling conditions as well as under load.

The electric tachometer consists of 2 elements, one of which converts the angular speed into a corresponding emf, and the second is an instrument measuring this emf.



1. Thrust[redacted] ring
2. Permanent magnets
3. Aluminum disc
4. Shaft
5. Counter springs
6. Induction transducer
7. Frame
8. Field coils of transducer

[redacted]

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During the rotation of the thrust ring (1) together with the magnets (2), a current will arise in the aluminum disc (3) , as a result of an induction of an emf in this ring, and this current will flow along the surface of the disc coupled with the magnetic flux of the permanent magnets (2). This current, by interacting with the magnetic field of the magnets (2), will create a moment of rotation of the disc (3) in the direction of rotation of the permanent magnets. The magnitude of the moment exerting an action upon the aluminum disc, will,all other conditions being equal, depend upon the rotation speed of the permanent magnets (2).

The moment of the current induced in disc (3) is balanced by the moment produced by the coiling action of the counteracting spring (5),

In this manner, due to the presence of spring (5), disc (3) will rotate along an angle, the magnitude of which is proportional to the angular rotation speed of the magnets.

Since frame (7) of the transducer is connected with shaft (4), rotation of the aluminum disc (3) along a certain angle will result in a similar angular rotation of the frame.

Since emf E_{α} of frame (7) in the induction transducer is a linear function of the position of the frame, it follows that emf E_{α} is a measure of the angular speed of the permanent magnets (2), or, which is the same, of the angular speed of the thrust ring. The thrust ring (disc) (1) is attached to a shaft connected by a transmission system, to the mechanism or machine, the angular speed of which is to be measured.

The permanent magnets (2) are built in the form of cylinders of "Magniko" alloy. The frame of the induction transducer is connected with two ferrodynamic measuring instruments, one of which is of the recording type and the other of an indicator type.

The tachometer designed for checking the number of rotations of the rotary table has a maximum measuring range of 800 rpm.

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6. Wattmeter for Power Control of Electric Motors in a Drilling Unit

The principal type of motor used in drilling oil wells in the USSR is an asynchronous machine with a 3-phase current. The power of motors used in drilling units is of considerable magnitude. Thus, on the drive of the rotary table, where 2 motors are installed, the total power is equal to 320 kw, while the power of the 2 motors acting on the drive of mud solution pumps amounts to 400 kw and the power of the 2 motors acting on the winch drive is equal to 320-500 kw. These significant power ranges utilized in various drilling installations require continuous control for their rational utilization.

Of particular importance is the control of power operating the electric drive system of a rotary table, since the magnitude of the rotary moment created by the motor acting upon the drive, is limited by the strength of the drill pipes.

Power control of the 3-phase asynchronous motor used in drilling is achieved in the simplest manner, as a result of the symmetry of the 3-phase voltage system and also of the equal load, with the aid of a single-phase wattmeter. Sush a type of wattmeter was developed at the Azerbaydzhan Industrial Institute.

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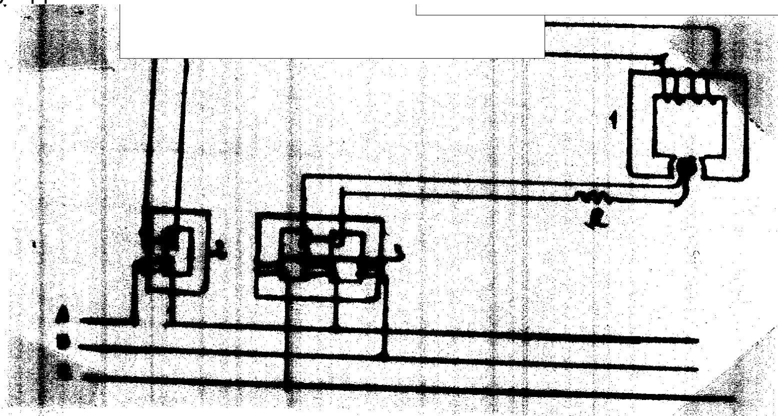

1. Single-phase wattmeter

2. Current transformer

3. Potential transformer

The field coil of the ferrodynamic wattmeter is intended for a current intensity of 5a. The frame of the wattmeter, which acts as the potential winding, is connected to a potential of 100 volts. The maximum current flowing through the frame of the wattmeter amounts to 100 ma. The resistance of the frame is equal to 85 ohm. The magnetic circuit of the wattmeter is calculated for an induction not exceeding 200 gauss.

As can be seen, all instruments designed at the Azerbaydzhan Industrial Institute are provided with ferrodynamic meters. L. F. Kulikovskiy worked on these instruments. His book "Electrical Measuring Instruments for the Control of Drilling Processes", published by Gostoptekhizdat, 1952, Moscow-Leningrad, describes the above-mentioned instruments.

L. F. Kulikovskiy defended his doctor's ~~thesis~~ dissertation in this field and one can get acquainted with his work by visiting the Lenin library in Moscow.

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7. AC Potentiometer

The principle of the operation of an ac balancer consists in that the measured emf is balanced by a certain potential resulting from the passage of operating current through a resistor of an auxiliary circuit.

With the aid of an ac potentiometer it is possible to measure the potential and emf of an ac current, the current, the resistance, the magnetic flux and other values. The ac balancer permits to determine not only the quantitative magnitudes of various values, but also their phase, i.e., to represent them in rather descriptive way by means of vector diagrams.

The ac potentiometer built at the AzII operates from an industrial frequency of 50 cycles and at 200 v.

With the aid of this potentiometer it is possible to measure the voltage of ac current up to 1.1 v, with the rectangular system of coordinates.

A phase sensitive ferrodynamic meter is used as a null indicator.

As is known, the ac current voltage is made of two components:

I_x, I_y where $I = \sqrt{I_x^2 + I_y^2}$; $\quad tg\,\varphi = \frac{I_y}{I_x}$

In the AzII ac potentiometer the applied unknown voltage is balanced only along one ~~of the~~ axis, i.e., either X or Y. Since the

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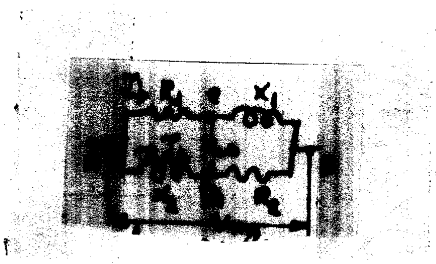
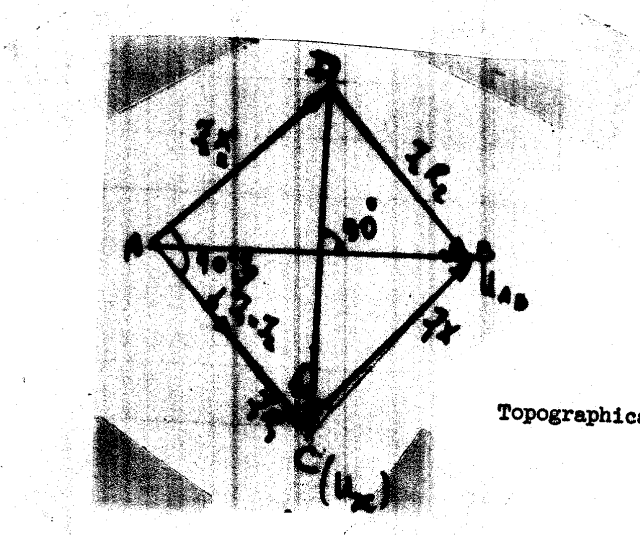
ferrodynamic meter is phase sensitive, the magnitude of the voltage in question was obtained along the individual axis of the coordinate system only when connected respectively to the either X or Y positions.

For obtaining the voltage differing by 90° the following circuit was used:

Here



Here the values of X and R are selected in such a manner that the I_{CD} would be perpendicular to I_{AB}



$I_{AB} \perp I_{CD}$

Topographical vector diagram

The excitation winding circuits of the ferrodynamic meter and the auxiliary resistors have switches. These switches are set in the respective positions depending on the vector phase of the measured

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voltages of I_x. With the change of the position of the contacts of these switches there will be a change by 180^o of the direction of the vector components, which balance the vector of the voltage in question (or emf), thus making it possible to determine the vector in a quadrant in which it is located.

The description of this potentiometer is given in the periodical "Elektrichestvo", No 6, 1947 by L. F. Kulikovskiy. Besides, the device is now displayed at the All-Union Agricultural and Industrial ~~Exposition~~ Exhibition USSR, Moscow.

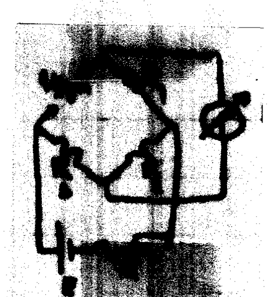
A. M. Melik-Shakhnazarov has introduced ~~the~~ electronics into the process of measurement of the described potentiometer. However, the measuring units did not undergo significant changes. The description of this is given in the Works of Az. I. I. for 1956-1957.

8. Device Measuring the Resistance of the Skin

This device is of significance to the medicine. By means of measuring the resistance of the skin to the passage of the current it is possible to diagnose various human diseases.

The resistance of the human skin for various diseases acquires different values in the vicinity of the elbow. By means of applying a special feeler made of a membrane it is possible to measure the resistance at this part of the elbow.

In accordance with a dc bridge circuit, the feeler is placed in one of the arms of the bridge, as shown in the circuit:



galvanometer

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This device was made to the order of the Azerbaydzhan Medical Institute (A.M.I.) under the direction of Professor Z. V. Yel'yashevich and Docent A. M. Melik-Shakhnazarov.

9. <u>Inclinometer</u>

This device measures the dip, azimuth, and the speed of well drilling for inclined drilling. All the components are placed inside of a 1.5 m tube.

Yuriy Vasil'evich Grachev, aspirant Frudman, docent Aleksandr Mikhaylovich Melik-Shakhnazarov, instrument building mechanics Yuriy Aleksandrovich Meshcheryakov and Mel'nikov were working on this inclinometer.

This inclinometer made at the Az.I.I. was displayed at the All-Union Agricultural and Industrial Exhibition in 1956.

Yu. V. Grachev defended his dissertation on this subject in 1956 at the Az.I.I. and obtained the degree of Candidate of Technical Sciences.

10. <u>Measurement of the Porosity of Rocks</u>

The measurement of rock porosity by electrical methods was developed in March 1957 by Docent A. M. Melik-Shakhnazarov, (Melikov) and docent Tofich Mamedovich Aliyev.

It was planned to develop a device operating at a high frequency.

11. <u>Measurement of Ground Pressure</u>

The device was ordered by the Mingechaurstroy in 1953-1954 for measurement of the ground pressure at tunnel arches.

The device was designed by Docent A. M. Melik-Shakhnazarov, T. M. Aliyev, and aspirant Il'yas Aliyevich Aliyev.

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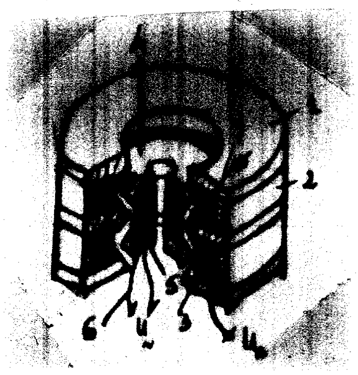
The measuring transducer of induction type based on ~~the~~ linear displacements was the first standard. A hermetically closed cylinder 16 cm in diameter, 8 cm high, had a protrusion on its surface to which the pressure was applied. The pressure caused the change in the gap of the magnetic circuit inside the cylinder, as a result of this the emf of the transducer also changed. This change caused the deflection of the frame of the ferrodynamic device.



The transducer is assembled from the rings 1, 2, 3, and 4, machined from Armco steel, while the rings 1 and 2 form a stationary core, and the rings 4 and 5 form a moving core. The excitation winding 6 is of a cylindrical shape and is placed between rings 4 and 5. The secondary winding 7 is also in the shape of two cylindrical coils connected to each other in opposition. The winding is placed between the rings 1 and 2.

12. Thickness Gauge ~~Caliper~~

In the oil industry the pump tubes (diameter 45 to 90 mm) are coated with chromium. This coating (40 to 60 microns) prevents ~~the~~ corrosion and wear of the tube walls. For the measurement of the

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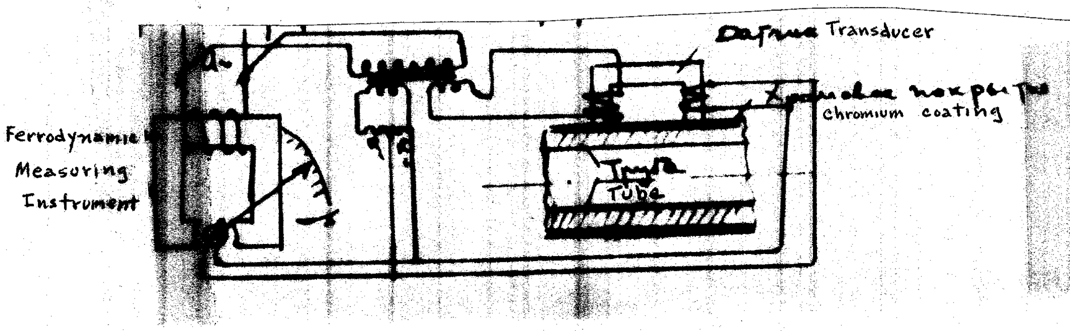
thickness of the chromium coating in 1944-45 L. F. Kulikovsky ~~has~~ designed a device the principle of which was based on the measurement of magnetic reluctance in the magnetic circuit.



With the change of the gap in a ⊓ shape magnetic circuit its magnetic reluctance is also changing, as a result of which an emf appears which deflects the frame of the ferrodynamic indicating meter. Since the chromium coating serves as a reluctance for the passage of magnetic lines of force, the change of the thickness of coating causes the deflection of the pointer of the device which is graduated in microns (0 to 150).

The resistances R_1 and R_2 serve to the measure the initial (zero) position of the pointer of the device.

The measurement of the thickness of nonmagnetic coatings with the aid of a magnetic principle was developed in the USSR in 1930 and ~~which~~ periodically appeared in the journal "Zavodskaya Laboratoriya" in the City of Moscow. Besides, the periodical "Elektrichestvo" has described ~~the description of~~ such methods.

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The above mentioned device was described in "Elektrichestvo" 1948 by L. F. Kulikovskiy.

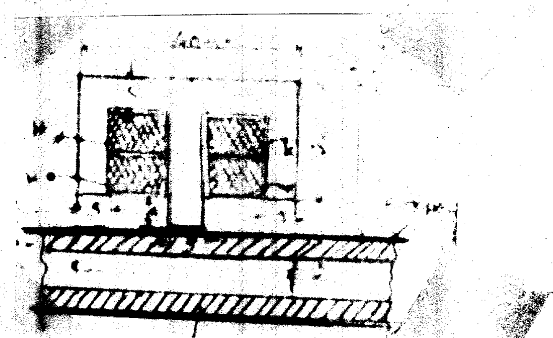
At the Az.I.I. was also built a dc potentiometer. The description of such devices appeared in "Zavodskaya Laboratoriya."

The transducer of the ac thickness caliper had a Π shape and practically touched at two points the coating. This resulted in the error of measurement and, besides, such transducers were made only for measurement of one diameter of the tube.

In order to eliminate these shortcomings, the transducers were changed to the Ш shape. The point of contact is at the center rod of the magnetic circuit, i.e., it is at a single point, so that with such a transducer it was possible to measure the thickness of coating of tubes of 45 to 90 mm diameter.

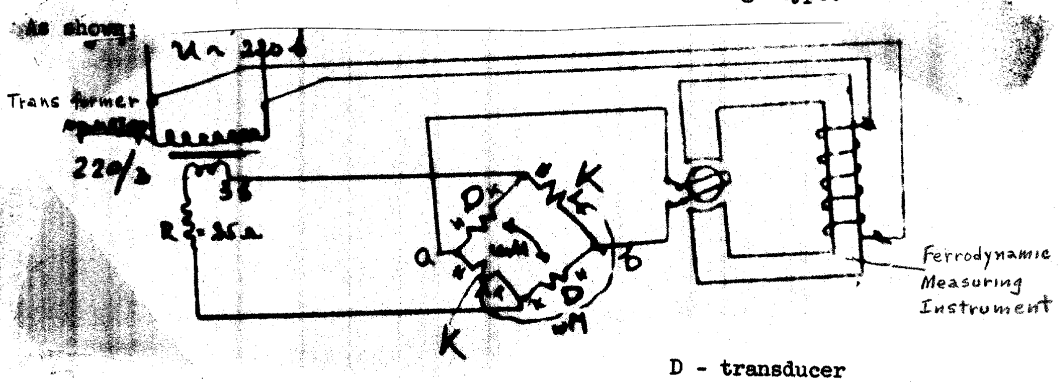
N - beginning of the coil

K - End of the coil



The magnetic circuit of the transducer is made of solid steel material, steel 3.

The electric circuit for this transducer is of a bridge type. As shown:



D - transducer

K - balancer

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The transducer and balancer were made individually. Both the transducer and balancer have two coils with a number of turns w = 250, wound with grade PEL enameled wire 0.215 mm diameter.

The dimensions of the transducer (balancer) magnetic circuit are given in the figure in mm.

In the measurement of the coating thickness the induction of the coils is changing, as a result of which a difference of potential appears between a and b, which causes the deflection of the frame of the ferrodynamic meter.

All the instruments described above were built only by the Chair for Basic and General Theoretical Electrical Engineering together with the Chair for Automatics and Telemechanics, which was organized in 1955-56. [redacted] 25X1 Work carried out at AzII is described in the following publications:

a. Trudy AzII (Works of AzII)

b. Novosti Neftyanoy Tekhniki (News of Petroleum Engineering)

c. Trudy Akademii Nauk Azerbaydzhanskoy SSR (Works of the Academy of Sciences ~~of the~~ Azerbaydzhan SSR)

d. Trudy Energeticheskogo Instituta Akademii Nauk Azerbaydzhanskoy SSR (Works of the Power Engineering Institute of the Academy of Sciences ~~of the~~ Azerbaydzhan SSR)

e. Energeticheskiy Byulleten' (Power Engineering Bulletin)

f. Izvestiya Akademii Nauk Azerbaydzhanskoy SSR (News of the Academy of Sciences ~~of the~~ Azerbaydzhan SSR)

g. Elektricheskiya Stantsii (Electric Power Stations)

h. Elektrichestvo (Electricity)

i. Zavodskaya Laboratoriya (Plant Laboratory) and others

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